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ABSTRACT

This monograph defines and describes research in the study of adoption of electronic text services in higher education institutions. Electronic text here includes text and graphic information encoded and transmitted via broadcast, signal, or cable, under user control. It places the diffusion of electronic text in higher education within the context of prior diffusion research; examines the perceived attributes of electronic text and the impact of these factors on the adoption process; and describes a series of discrete electronic text services specific to higher education. Characteristics of adopters are discussed, as well as perceived attributes of innovations that can affect their adoption, including their relative advantages and risk, compatibility, complexity, trialability, and observability. Applications of electronic text in higher education that are described include computer-aided instruction, computer-assisted registration, and electronic versions of discussion groups, "office hours," student advising, catalogs, course scheduling, course syllabi, bookstores, libraries, campus box offices, student record services, admissions screening services, "invisible colleges," and conventions and journals. A causal model is explained that allows, through laboratory simulations, the study of the relationship between perceptions that affect the adoption or the rejection of electronic text as an innovation. Eighteen references are listed. (LMM)

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THE DIFFUSION OF ELECTRONIC TEXT AMONG UNIVERSITY STUDENTS AND FACULTY: A STRATEGY FOR LABORATORY RESEARCH

Monograph Number One
of the
Electronic Text Monograph Series

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The Annenberg/CPB Project

The mandate of The Annenberg/CPB Project over a 15-year period is to create innovative, quality college-level materials and to demonstrate unique applications of telecommunications technologies in higher education problems.

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ABOUT THE MONOGRAPH SERIES

The Electronic Text Monograph Series is a refereed series of scholarly research reports generated from the study of electronic text in higher education. The monograph series includes scholarly reports of research conducted by the Electronic Text Consortium, as well as other scholarly studies of electronic text in higher education.

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MONOGRAPH 1

THE DIFFUSION OF ELECTRONIC TEXT AMONG UNIVERSITY STUDENTS AND FACULTY: A STRATEGY FOR LABORATORY STUDIES

January 1985

by

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ABSTRACT: Characteristics of individuals affect their perceptions of the attributes of electronic text as an innovation. This monograph paper seeks to link research on electronic text diffusion to prior diffusion research. Then attributes of electronic text in higher education are described. Finally, a strategy is outlined for studying electronic text innovativeness in a laboratory setting, by manipulating objective attributes of the innovation and measuring projected adoption.

Monograph One in the refereed monograph series, published by the Electronic Text Consortium, Electronic Text for Higher Education.

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This monograph serves several purposes. The overarching effort in the present monograph is to define and describe a stream of research in the study of adoption of electronic text services in institutions of higher learning. To do so, a number of separate purposes emerge. Those purposes include:

1. To place the diffusion of electronic text in higher education within the context of prior diffusion research.

2. To examine the perceived attributes of electronic text and the impact of these factors on the adoption process.

3. To describe a series of discrete electronic text services specific to higher education.

4. To explicate a causal model for manipulating attributes of electronic text (including the discrete services described) in a laboratory setting to study relations between concepts that affect the adoption or rejection of electronic text as an innovation.

A rationale for pursuit of these purposes helps to organize these several themes in the present monograph. First, electronic text in higher education must be defined in the context of prior diffusion-of-innovations research. This purpose is best served through a review of classical diffusion research, notably the contributions of Everett Rogers (1983), as well as marketing-oriented research of discontinuous, technological innovations. This latter review takes special note of the theoretical contributions of Elizabeth Hirschman (1980) and other marketing-oriented scholars. To provide a context for electronic text as an innovation, a distinction between functions and services of electronic text is drawn. The second purpose--the examination of perceived attributes of electronic text--is served by examining each of the classical perceived attributes of innovations and linking them to the specific

innovation of electronic text. Using perceived attributes as a foundation, a number of electronic text services in support of higher education are described. The purpose of this third effort is to provide an indication of the diversity of services that electronic text can provide to higher education. At a more operational level, such descriptions of electronic text services provide a template or guide for the development of simulations of such electronic text services within the laboratory. Laboratory simulation of electronic text services is integral to the fourth purpose of this monograph. The fourth purpose is to sketch a strategy for studying the diffusion of electronic text in higher education through laboratory simulation of text services. Given that actual adoption of electronic text services by individual students and faculty requires prior adoption and implementation of such services by institutions of higher education, laboratory simulations provide a mechanism for studying projected individual adoption, a proxy measure of actual adoption. A causal model of the relationships between key concepts and the laboratory simulation experience is provided at the end of this monograph. The purpose of this model is to explicate relations between key concepts and spell out a strategy for the study of projected adoption through the manipulation of the objective attributes of electronic text through simulations in the laboratory.

Adoption of Innovations Defined

The purpose of this section is to define innovations and adoption, both generically and specific to electronic text. An innovation is an "idea, practice, or object that is perceived as new by an individual or other unit of adoption." Adoption is the "decision to make full use of an innovation as the best course of action" (Rogers, 1983, pp. 11-21). As regards electronic text

services, the idea itself is innovative. This is especially true in the setting of higher education. In order to explore electronic text services as an innovation, the innovation itself requires some explanation.

The Innovation of Electronic Text

Carey (1983) provides a useful set of definitions of key concepts related to electronic text services. Carey (1983, p. 3) defines electronic text as a "generic term for all forms of text and graphical information that are digitally encoded and transmitted via broadcast signal, cable, and telephone wire; or made available on a diskette/casette." The present monograph adds the additional restriction that the display of electronic text on a television screen or computer terminal is controlled by the user. Eliminated from this definition is "cable crawl," the continuous display of words on the television screen in an flow uncontrolled by the user. The medium of electronic text is distinct from broadcast or cable video programming not by virtue of the display of words on the screen instead of pictures, but by virtue of the user's active selection and control of frames of textual information displayed. Electronic text, in this sense, is an "active" medium like print media, rather than a passive medium like television.

Contrasting Teletext and Videotex

Carey (1983, p. 3) defines two distinct forms of electronic text: teletext and videotex. He defines teletext as:

> ...one-way electronic text that is transmitted via a portion of a broadcast or cable signal. This term may have a modifier that further defines it. For example, broadcast teletext generally refers to electronic text transmitted via the vertical blanking interval of an over-the-air television signal. Cable teletext refers to one-way transmission of electronic text via a portion of a cable signal. SCA teletext refers to one-way transmission

of electronic text via a portion of an FM radio signal. Teletext can be viewed as the continuous transmission of a "stream" of text pages or frames. The user actively selects desired frames of text by "grabbing" them electronically as they "cycle" through the user's receiver. Carey's definition focuses on the transmission mechanism as key modifier. In the present monograph, the mechanism of transmission will be of lesser importance. Rather, only attributes of electronic text that are of relevance to the user will be distinguished here. This issue is considered in more detail later in the present monograph.

Carey (1983, p. 3) defines videotex as "interactive electronic text transmitted via telephone line or a two-way (coaxial) cable system." This definition redefines this concept from the generic descriptor it once was to a more narrow concept once referred to by Smith (1980) as "view data." Interactive electronic text requires the user to send a signal via cable or phone line to a central computer. This signal prompts the computer to display certain text on the user's screen. In addition, the user can "store" information in the computer or have the computer perform any number of tasks. For some uses, such as requesting the display of a course syllabus on the user's screen, videotex and teletext may appear identical to the user. Other uses, such as purchasing a textbook or taking a course quiz "on line," require the interactive capacity of videotex.

The Attribute of Transmission

A key element of Carey's (1983, p. 3) definition of electronic text is the notion of transmitted text. That is, textual information may reside in a computer data base in relatively static form, without opportunities for routine updating and changes. Statistical application packages, such as SPSS

or SAS, are examples of highly static information sets which often display frames of information visually on computer terminals or TV screens. SPSS and SAS are not, however, forms of electronic text in the strict sense of the definition offered by Carey (though reasonable people could disagree on points such as this). The concept of electronic text, as used in the present monograph, includes the notion transmission or dissemination of information. Such transmission may be instant, as with some electronic text news services, or may occur at a more relaxed and infrequent pace, as when the digital information is distributed by diskette or casette tape to users of personal computers.

In between the "instant" teletext and videotex information services and the more static, infrequently updated diskette/casette distribution services is the practice of downloading. Carey (1983, p. 3) defines downloading as the "transmission of electronic text or computer software into ... a personal computer, where it is stored and available for use after the transmission ends." Rather than maintain continuous transmission of textual information to the user (as in teletext) or maintain continuous communication linkage between the user and the central computer (as in videotex), downloading permits the quick, efficient transmission of a set of electronic text to the user's receiver (usually a personal computer) where it is stored. The user accesses the information using the capabilities of the personal computer without maintaining ongoing linkage with the electronic text service. As such, downloading is an intermediate distribution mechanism; downloading is "slower" at updating information than continuous linkage but "faster" than diskette/casette distribution services. As will be spelled out in a subsequent section of the present monograph, the method of dissemination is relevent to the present monograph only as it affects the user's perceptions

and uses of electronic text services.

Innovations and Continuity

What kind of an innovation is electronic text in higher education? In order for administrators and planners in higher education to take advantage of prior diffusion research, electronic text needs to be placed in its proper context among such diverse innovations as hybrid corn, methods of family planning, and oven roasting bags. While all innovations are, in some way, "innovative," they vary widely in the degree to which they depart from past ideas or practices. Robertson (1971) provides a useful framework for analyzing the degree to which an innovation is "innovative." Robertson (1971, p. 14) suggests that any innovation may be classified as continuous, dynamically continuous or discontinuous.

Robertson (1971, p. 14) defines continuous innovations as those exerting the least influence on established patterns: "Alteration of a product is involved, rather than the establishment of a new product." A computer screen may be designed to reduce glare by texturing the screen surface. Such an innovation would be classified as continuous. A product has been altered, but the established patterns of usage are little altered.

A dynamically continuous innovation is "more disrupting," but "still does not generally alter established patterns" (Robertson, 1971, p. 14). Such innovation "may involve the creation of a new product or the alteration of an existing product." An example might be the adoption of an electronic typewriter with small internal memory and a single line display of typed text. Such an innovation, if adopted by a typing pool already using electric typewriters, would be somewhat disruptive of the way in which individual typists use their typewriters. However, general patterns of work flow and

organization would not be greatly altered.

A discontinuous innovation, on the other hand, "involves the establishment of a new product and the establishment of new behavior patterns" (Robertson, 1971, p. 14). Returning to the dynamically continuous example, a typing pool might adopt a centralized word processing system, where disk storage and high-speed printing are centralized. Such a system might replace individual electric typewriters. Along with the establishment of the new product, time-honored (and perhaps cherished) patterns of work and organization are altered. Centrally-stored files can be examined by others, including supervisors. Access to high-speed printers would require systems of priorities that might greatly alter past patterns of "who goes first." New relationships regarding the use and control of shared-access resources would emerge. New behavior patterns would emerge.

Electronic text involves both a new product and new user behavior patterns. In later sections of this monograph, various electronic text services in higher education are detailed. These applications involve new technology and changes in time-honored ways of conducting the business of universities. While reasonable people can disagree, electronic text is treated as a discontinuous innovation in this monograph.

Hirshman (1981) provides another way of looking at types of innovations. Each innovation, she argues, can be described in terms of two attributes: technology and symbolism. A technological innovation has some tangible feature completely new to the product class. A symbolic innovation, on the other hand, may involve no major tangible feature to distinguish it from other products in that product class but communicates different social meaning than previously. Many innovations may involve some degree of both symbolic and technological innovation. However, most can be thought of as

either predominantly symbolic or predominantly technological innovations. Hairsyle and clothing innovations are symbolic innovations; computer equipment and electronic text services are technological innovations.

The classification of electronic text services as discontinuous, technological innovations has important implications for the way in which characteristics of the potential user and the perceived attributes of the innovation interact to affect an adoption decision.

Characteristics of Adopters

The purpose of this section is to consider the characteristics of potential adopters which impact the adoption of electronic text. Rogers (1983, pp. 241-270) has isolated eight socioeconomic characteristics, twelve personality variables and ten communication characteristics of individuals that generically affect "innovativeness." These generalizations are derived from about 3,000 studies of the diffusion of innovations. Innovativeness is frequently defined among rural sociologists as the "degree to which the individual is relatively earlier in adopting new ideas than other members of the social system" (Rogers, 1983, p. 242). The presumption that everybody will eventually adopt the innovation has been frequently criticized (Rogers, 1983, p. 91-118). More important, patterns of innovativeness derived from studies of innovations in agriculture or in developing nations do not readily apply to discontinuous, technological innovations in post-industrial settings. For example, a variable such as literacy--a good indicator of innovativeness in rural sociology--has little utility in post-industrial settings.

While a number of variables from classical diffusion research are of little utility in studying electronic text, other variables have proven to be strong predictors of adoption. These variables are considered below.

Age of Potential Adopter

In examining attributes of "innovative" individuals with regard to electronic text services, many characteristics of innovators in other settings do not seem to apply. A series of studies through the Center for Communications at San Diego State University provide strong evidence that age is negatively correlated with projected electronic text adoption. Potential adoption of electronic text was operationalized as follows: respondents were asked what they would pay for electronic text services on a monthly basis, after exposure to an actual demonstration of such a service. Younger individuals are more likely to project adoption of electronic text services than older individuals. This relationship holds, even when the influence of other predictors of adoption are controlled (Dozier and Hellweg, 1984). Interestingly, age is one characteristic of individuals that is generally held to be unrelated to innovativeness in diffusion studies in developing nations and in rural sociology (Rogers, p. 251).

Loss of Human Contact

The fear of lost human contact through the use of electronic text services for banking and shopping is negatively related to projected use of such services (Dozier, Hellweg, Ledingham, 1983). On the other hand, people seeking to avoid secondary social relationships in the marketplace ("crowds") are more likely to adopt and use such services. This evidence is clearly indicative rather than conclusive. However, the impact of electronic text on face-to-face contact among humans is worthy of consideration. As more and more secondary relationships involving face-to-face communication are replaced by electronic text (ATMs replace secondary relations with bank tellers), individuals with few social relations (e.g., the retired) will become

increasingly isolated and lonely. This can be seen in the tendency of retired individuals to enjoy participation in telephone surveys; often retired persons are reluctant to end the phone call at the end of the survey!

Product Class Experiences

A final set of individual characteristics that are strong positive predictors of projected adoption are prior experiences in the product class. These characteristics include use of bank Automated Teller Machines (ATM), prior "hands on" computer experiences at home or at work, and (specific to cable-based electronic text services) subscription to Home Box Office, a tiered cable service offered for an additional charge each month (Dozier, 1983).

Attributes of Innovations and Changing Perceptions

The importance of prior product experience takes on special significance when results of another Center for Communications study are considered. Perceptions of attributes of electronic text shift dramatically as a result of product experiences. In a laboratory study, 107 subjects were asked to project their adoption of electronic text services after a brief written description of such services. Projected adoption was operationalized as the dollar amount each subject was willing to pay each month for such services. Then subjects were demonstrated a simulated electronic text service on a personal computer. Following that demonstration, subjects were again asked to project their adoption of such services. The per-month fee subjects were willing to pay for electronic text services increased nearly 40% after a brief (less than one hour) demonstration (Dozier, 1983). Hiltz and Turoff (1978) have found similar shifts in their studies of computer conferencing.

Ostlund (1974) argues that the individual's perception of attributes

of an innovation provides more powerful predictions of innovation adoption than do characteristics of the individual. In a study of a new oven basting bag, Ostlund found that individual perceptions of the innovation, especially individual perceptions of relative advantage and compatibility, could be used to accurately identify 79% of the innovators who actually bought and used the product shortly after its introduction in a test market. Adding additional measures of individual socioeconomic status, social mobility, venturesomeness, and self-confidence in problem solving to the discriminant analysis did not notably improve the accuracy of the prediction.

While Ostlund's innovation is not nearly as technological nor as discontinuous as electronic text services, the findings of that study underscore the importance of the perceived attributes of an innovation in explaining its rate and level of adoption among individuals.

Perceived Attributes of Innovations

Given the importance that perceived attributes of innovations seem to play in their adoption, innovation attributes warrant special scrutiny. This section examines five generic attributes of innovations and seeks to link these generic attributes to the innovation of electronic text. The effort here is to derive guidance from over 3,000 diffusion studies conducted in many cultures to our understanding of a specific innovation (electronic text) in a specific "cultural" setting (universities in post-industrial societies). Rogers (1983, pp. 213-252) identifies five key perceived attributes of innovations that have been shown to generally affect the rate and level of adoption. Those attributes include: relative advantage, compatibility, complexity, trialability, and observability.

Relative Advantage and Risk

Relative advantage is the perception that an innovation is better than the product or idea that the innovation supersedes. Rogers (1983, p. 214) makes an important observation that's particularly relevant to the study of electronic text. He notes that the pocket calculator "which sold for about $250 in 1972" could be bought for less than $10 in 1976. At the same time, the tasks that pocket calculators could perform changed significantly. For example, the creation of a wafer-thin calculator that could "remember" a number after the unit was shut off permitted the creation of calculators for check books where the running balance was retained in permanent storage after the calculator was shut off. In the 1972 pocket calculator, square root values were calculated through a complex procedure where the final value was approximated. By 1976, the square root function could be performed on a number through a single keystroke. The percent function was also added. Relative advantage and other perceived attributes of the innovation can be radically affected by alterations in the technology, the cost of technology, and the objective attributes of the innovation.

Closely linked to relative advantage is the construct of risk. The perception of relative advantage requires an evaluation of current ideas or practices vs. innovative ideas or practices. As the innovation becomes more technological and more discontinuous, the perception of relative advantage is tempered along a separate dimension by the evaluation of the certainty of perceptions of relative advantage. Uncertainty about the accuracy of perceptions of relative advantage is perceived risk.

For example, a faculty member might perceive relative advantage in the use of electronic mail for distribution of course syllabi to students over a campus electronic text system. However, the electronic text system proposed

would be installed and run by the campus computer center. The faculty member's past experiences with campus computing have been frustrating: inadequate documentation, lost output, frequent system crashes, errors in accounting, and so forth. While the electronic text system (a "stand alone" hardware/software package) has worked well at other institutions, the local version will nonetheless be administered by campus computing. The involvement of campus computing introduces an element of uncertainty or risk into the faculty member's overall perception of superior relative advantage of the electronic text system over current paper-based practices.

Relative advantage of discontinuous innovations may rest not simply in the perceived advantage of its individual components, but in the cumulative "critical mass" of its collective services and products. In the perceptions of relative advantage of electronic text services, the whole may indeed be greater than the sum of its parts. In a focus group study of commercial electronic text information services, sponsored by a subsidiary of American Can Corp., participants were asked to place dollar values on each of a series of electronic text services. Several participants expressed little interest in the services and placed little or no dollar value on them. However, when asked to evaluate all the discrete services as a whole, these same participants becme very interested in the package as a whole and placed a significant dollar value on the total package.

Compatibility

Compatibility is the "degree to which an innovation is perceived as consistent with existing values, past experiences, and needs of potential adopters" (Rogers, 1983, p. 223). Specific to electronic text services, prior studies indicate that past experience in the same product class (ATMs,

computers) is positively related to projected adoption. Looking at adoption generically, Rogers speaks of technology clusters, or "distinguishable elements of technology that are perceived as closely interrelated" (Rogers, 1983, pp. 226-227). Adoption of one innovative idea within a single technology cluster increases the probability of adopting other elements in that same cluster because the new idea is compatible.

In a sense, compatibility is the perception that the innovation isn't really all that innovative to the potential adopter after all. The affective roots of this construct can be seen in Rogers' (1983, p. 224) discussion of compatibility in terms of "deeply embedded cultural values." Focusing specifically on technological innovations, Hirschman (1980) argues that adoption of a discontinuous innovation is enhanced by product class familiarity. This familiarity may reflect, in part, a degree of compatibility with existing values, experiences, and needs.

For example, most journalism professors left professional practice when most newspapers and broadcast news operations used manual or, at best, electric typewriters. In the meantime, the news business has widely adopted VDTs (video display terminals) for preparing and editing news copy. Many university journalism programs are scrambling to catch up with industry practices by installing VDTs in the classroom. This change is met with much forboding and turmoil among faculty wed to an older technology. Manual typewriters are wistfully praised for their dependability and familiarity. The older technology is seen as more compatible with time-honored practices. In fact, as most journalism department secretaries will attest, the older manual typewriters were anything but reliable. In the absense of any information about VDTs and their relative reliability, perceptions of relative advantage of manual typewriters are more likely the product of compatibility.

This example serves to illustrate the subtle interplay of compatibility, relative advantage, and risk. As the risk of perceived relative advantage increases, because of incomplete information, one can expect the demonstrated compatibility of current practices to be viewed as advantageous.

Compatibility is an affective perception of an innovation. More information about the innovation may either increase or decrease perceptions of compatibility. Potential adopters also have cognitive perceptions of innovations. One such cognitive perception is that of complexity. Complexity is another attribute of innovations that affects adoption.

Complexity

Complexity is the "degree to which the innovation is perceived as relatively difficult to understand and use" (Rogers, 1983, pp. 230-231). Hirschman (1980) argues that product class familiarity leads to the reduction of cognitive effort required to comprehend the innovation. Reduction of cognitive effort is related to the perceived attribute of complexity, the degree of discontinuity of the innovation for the potential adopter. Prior experiences in the product class may reduce perceptions of complexity by assisting the potential adopter in constructing a cognitive map of the innovation itself. Information scientists refer to this process as "mental modeling."

In considering discontinuous, technological innovations, Hirschman (1980) introduces the constructs of interconcept networks and scripts to develop a model of how the potential adopter reduces perceptions of an innovation as complex. Interconcept networks are linkages between the various attributes of products within the same product class or technology cluster. Scripts or episodic schema are mental storage areas that "represent a system

of temporally and causally related events" (Hirschman, 1980, p. 287). Interconcept networks are structural connections that link innovations of a technology cluster together by correlations among attributes of elements of the product class. Episodic schema, on the other hand, are stored representations of the process of using a particular innovation within a technology cluster.

Hirschman (1980) posits that, as potential adopters use more products within a product class or technology cluster, structural linkages between attributes of the different products become more complete and detailed. The individual reaches closure on comprehension of the innovative idea or product by noting the different attributes of the innovation are "like" known attributes of other ideas or products and "not like" other attributes of ideas or products within that technology cluster.

For example, an individual might note that an electronic text home banking service is like an automated teller machine at the bank, because funds can be transferred electronically from one account to another and balances checked. Electronic banking at home is unlike automated teller machines in another important attribute: electronic text home banking can't give cash from the user's terminal.

An individual also reaches closure on comprehension through another cognitive tool, by mentally constructing the process of using the innovation by piecing together scripts from other elements of the technology cluster which the individual has already used. For example, the need to type in a password to access home electronic text banking services is the same "script" that automated teller machines at banks require. While passwords are a shared attribute of ATMs and electronic text home banking (interconcept network), the familiarity with this "script" from prior ATM usage makes the steps in using

electronic text home banking easier to comprehend. The processes or episodic schema are similar. This process of comprehending a discontinuous innovation through development of interconcept networks and episodic schema is termed consumer creativity (Hirschman, 1980, p. 288).

Trialability

Trialability is the "degree to which an innovation can be experimented with on a limited basis" (Rogers, 1983, p. 231). Some innovations like vasectomies and tubal ligation are pretty much "one shot" adoptions of an innovation. If the adopter decides later that he or she doesn't like it, too bad! If the potential adopter perceives adoption as irrevokable, the probability of adoption, all other factors being equal, is reduced. On the other hand, innovations that permit the potential adopter to "try them out" without penalty are more likely to be adopted because they are more likely to be tried.

This concept is more applicable to adoption decisions at the organizational level of analysis. Institutions such as universities are unlikely to adopt electronic text services in support of their missions if wide-ranging and relatively irrevokable commitments of resources and organizational prestige are required. At the individual level of analysis, trial use of electronic text services in addition to the more traditional methods of receiving those same services seems likely. Under such "trial" conditions, optional adoption of electronic text with traditional fallback services available may reduce the complexity and increase the compatibility of the innovation. The trialability of electronic text varies with the degree of commitment that a potential adopter must make with regard to user equipment. Such equipment can be rented for limited periods of time (increasing

trialability) or purchased outright for a significant sum of money (reducing trialability).

Observability

Observability is the "degree to which the results of an innovation are visible to others" (Rogers, 1983, p. 232). Specific to the technology cluster of computer-related innovations, Rogers (1983, p. 234) notes the distinction between hardware and software which serve as metaphors for many non-computer innovations. Hardware consists of the material or physical objects that embody the innovation. Software is the information base of the tool, the instructions or protocol for using the material object of the innovation. While hardware, such as an electronic text user terminal, is readily observable, the software that define the applications of the system are less observable. The information base may only become comprehensible through demonstration or use, through opportunities to develop episodic schema and interconcept networks.

Attributes of Electronic Text

This section considers the attributes, both objective and perceived, of electronic text in greater detail. Rogers' generic concepts for the perceived attributes of innovations must be reduced to constructs specifically applicable to electronic text services. If electronic text services were stabilized innovations, the process of developing such constructs would be greatly simplified. Rogers' (1983, p. 214) observations about the evolution of the pocket calculator and the transformation of its objective attributes during the 1970s are relevant to this point. As Carey has observed with regard to electronic text services, the innovation is a fluid "moving target" that challenges researchers seeking to study it. The innovation that one

begins to study may transform itself in the middle of the study. Toward that end, here are some maxims that apply to the objective attributes of electronic text services:

> 1. Don't treat the current technological attributes as constants. Rather, presume that these attributes are variables and proceed to estimate the range of variance that one might expect to see over an extended period of time with regard to that attribute.
>
> 2. Some attributes are important at the organizational level of analysis while other attributes are critical to the technical implementation of electronic text services. However, many such attributes are invisible to the user at the individual level of analysis. Attributes invisible to the user are not perceived attributes at all. For purposes of studying adoption at the individual level of analysis, forget them.
>
> 3. Begin with and attempt to retain the user's perspective whenever examining attributes of the innovation. What does the user see and experience?

Using these maxims as a guide, the attributes of various electronic text services can be approached from the potential user's perspective. As Carey's taxonomy indicates, electronic text systems and services vary widely in their attributes.

Distinguishing Functions and Services

For purposes here, separating electronic text functions from electronic text services is useful. Functions are capabilities or operations that the electronic text system supports. Paisley and Chen (1983) identify two categories of functions in a separate typology. What this monograph defines as a function, Paisley and Chen (p. 23) define as presentation features and inputting and command features. Presentation features include display rates, character resolution, upper/lower case capability, line length, lines per screen, graphics resolution, motion, music and sound effects, synthesized speech, and keyboard symbols. Inputting and command features

include the input device used (keypads, keyboard, etc.) and the command language. For purposes of this monograph, all of these features are treated as system functions.

Services are the application of those functions or operations to help the user do certain tasks or accomplish certain objectives. These services are what Paisley and Chen (p. 23) define as content features. Content features, according to Paisley and Chen, include instructional software, text files, message files, and other databases. In this monograph, content features are called services.

Paisley and Chen (p. 21) point to the subtle interweaving of hardware and software, of hardware/operating system attributes and the more flexible attributes of a software-based computer service:

> The computer technologies are remarkably varied in their operating characteristics or...the 'features' they present to the users at the 'interface.' The dividing line between structure and function, quite distinct in older print and electronic media, is blurred in computer media by the equivalence of features implemented either in hardware or in software. Because hardware-implemented features are more expensive to change when systems are being modified to perform different functions, there is a design preference for software-implemented features. Software rather than hardware thus determines much of what a user sees and uses. As a consequence, the features of computer systems have an amorphous reality.

While many features or functions are driven by the operating system software, they take on many attributes of hardware. That is, they are not easily changed because of the "ripple" effect that such changes exert on all other applications or services supported by the system. Services, on the other hand, may implement features specific to a service package that, on another system, would be hardware driven. The functions that an electronic text hardware and operating system support set the outer parameters on the types of services that can be offered.

Table 1 provides a checklist of functions or system attributes that a potential user might evaluate in the development of an interconcept network within the technology cluster of electronic text. As the table indicates, different electronic text systems support different sets of objective attributes. Systems vary in the number of text pages they support, the sophistication of graphics displayed, the speed with which graphics can be detailed on the screen, the ability to send numeric or alphanumeric data from the user's terminal to a central computer, and the ability to send messages to other users. The presence or absense of these functions affect the potential adopters perceptions of relative advantage and complexity. However, from the adopter's perspective, the impact of functions on perceived attributes is not easily separated from the electronic text services or products those functions support.

As with functions, electronic text systems support a variety of services. Generically, electronic text services include news, sports, business news, stock reports, restaurant and theater reviews, banking services, catalog shopping, travel reservations, and a variety of other services. Specific to education, a number of services can be projected from services universities now provide through more conventional channels.

A Classifying Scheme

Allen, Hickey and Molise (1985), in another paper in this monograph series, provide a useful scheme for classifying electronic text products and services in support of higher education. Electronic text instructional communication is "designed to facilitate acquisition of specific competencies" (Allen, Hickey, and Molise, 1985, p. 3). Allen, Hickey and Molise provide detailed analysis of instructional communication via electronic text.

Table 1.

Checklist of Electronic Text Functions (System Attributes)

From a User's Perspective

Functions (System Atrributes)	YES	NO	Examples
1. Can the user control the pages to be displayed on screen via control device?		X	"cable crawl"
	X		videotex, teletext
2. Can a television set be used to display textual information?		X	some computer-based services using larger format
	X		cable-based teletext, videotex
3. Can information available to the user be updated instantly?		X	diskette, casette-based distribution; downloading
	X		teletext, videotex via cable, phone
4. Are the available pages of information greater than 200?		X	broadcast teletext
	X		cable teletext, videotex
5. Are the available pages of information greater than 4,000?		X	broadcast, some cable teletext
	X		videotex
6. Can the user receive simple graphics along with text?		X	strict ASCII-based service like CompuServe
	X		INDAX I (cable-based videotex)
7. Can user receive complex graphics with near-photo quality?		X	INDAX I
	X		Telidon-based teletext
8. Are these complex graphics displayed instantly on the screen (1 sec. or less)?		X	Viewtron (phone-based, Telidon)
	X		INDAX II*

*Cox Cable announced suspension of development of INDAX II in October, 1985, reflecting the general trend toward phone-based, microcomputer-based implementation and away from cable-based systems.

Table 1 (CONTINUED).

Checklist of Electronic Text Functions (System Attributes)

From a User's Perspective

Functions (System Attributes)	YES	NO	Examples
9. Can the user perform any functions with this service, other than select pages to read?		X	teletext
	X		videotex
10. Can the user type in letters of the alphabet, as well as numbers?		X	keypad-based service like INDAX I
	X		keyboard-based service like ViewTron
11. Can information typed in by the user be saved electronically once the user terminal is shut off?		X	INDAX I information services
	X		INDAX I bank at home
12. Can user perform complex searches by keywords of information in the data base?		X	INDAX I
	X		ERIC, DIALOG
13. Can the user send messages to other users electronically or to an information provider (e.g. teacher)?		X	INDAX I
	X		CompuServe
14. Can the user participate electronically in conferences (e.g. class discussions) where messages are transmitted and stored electronically?		X	INDAX I
	X		DialComm
15. Can the user make a "hard" or printed copy of the information sent or displayed on the user's terminal?		X	INDAX I
	X		CompuServe

Electronic text informational communication also provides information "that may be useful to the learner, but which is not directed towards acquisition of specific competencies." In addition, electronic text has many instrumental or tool uses in higher education (Allen, Hickey and Molise, 1985, p. 5). These applications include authoring systems and programming languages, but also encompass a series of electronic text services/products that assist in task completion. These tasks frequently involve the interactive capabilities of the system. These different applications of electronic text are considered in the next section of this monograph.

Some Applications of Electronic Text in Higher Education

This section is dedicated to briefly describing a number of electronic text services (but not all possible services!) in higher education. While quite lengthy, this section furthers several important objectives of this monograph. One objective is to indicate the diversity of potential applications of electronic text in higher education. A second objective of these descriptions is to serve as useful building blocks for simulating electronic text services in a laboratory setting. As will become apparent in the final sections of this monograph, the simulation of realistic electronic text services in the laboratory requires a detailed description of what such services would be and exactly how those services would work. The realism of the simulation experience is directly related to the external validity of the findings.

A number of such electronic text services are detailed in the subsections that follow. Each cluster is an attempt to perform a current university function through electronic text. As will be developed in later sections of this monograph, these services become the objective attributes of

the electronic text innovation. Perceived attributes of the innovation have foundation in these objective attributes.

In the following applications, a typical large university hosts the electronic text system. This hypothetical phone-based system can be used by any student within the university service area, through use of an 800 number or similar mechanism to eliminate long distance phone charges. The user terminal hooks to any television set; the terminal is issued to currently-enrolled students. In addition to home units, many public access terminals are available in many locations throughout the campus. The system is a full videotex system, supporting two-way transmission of information.

Computer-Aided Instruction

Allen, Hickey and Molise provide a thorough treatment of computer-aided instruction (CAI) and computer-managed instruction (CMI). In that paper, CAI and CMI are viewed as media for delivering instructional communication. A key argument in that paper is that the effectiveness of CAI and CMI rests not in the inherent advantages and disadvantages of the medium but in the design of such instruction. Poorly-designed instruction can reduce the effectiveness of CAI and CMI at least as easily as it does in other modes of instruction. Further, sophistication in the design of CAI and CMI is evolving. Artistic design, where the producer's internal sense of aesthetics dictate production decisions, is only slowly bowing to raw empiricism, trial and error evaluation of the effectiveness of artistically-based designs. The analytic/systematic approach, where design principles are derived from formal instructional theory and empirically tested, is only in its infancy.

However, the following generalizations are consistent with the history of CAI and CMI. First, properly-designed CAI and CMI can replace or support

more traditional modes of instruction with equal effectiveness in student achievement of stated competencies. Second, some instructional content areas are better suited to the objective attributes of CAI and CMI than are other content areas. In teaching basic writing skills, for example, existing software can be used to edit material written on a word processor. Existing CAI software is extremely efficient at checking spelling, grammatical, and punctuation errors. CAI demonstrates reduced effectiveness at "higher order" editing functions, such as stressing active rather than passive construction. (Existing software can detect passive constuction, but cannot tell whether such construction is appropriate in the context of the entire piece.) Third, the relative advantage of electronic text instructional communication rests in interactive capabilities of the system. Using electronic text to disseminate sequential pages of text (without feedback or branching capabilities) offers few user benefits over printed materials.

The relative advantage of electronic text instructional communication to students (assuming proper design) includes reduced transportation costs, improved evaluation and feedback from the instructor, and scheduling convenience. Relative advantage to faculty and the university include more efficient use of faculty time, greater service to larger numbers of students, opportunities to serve student populations not able to attend on-campus instruction (distant learners), and the development of formal principles of instruction based on competency objectives and formal evaluation of impact.

Disadvantages for students include loss of face-to-face contact with other students and faculty. The research question is: "Under what circumstances can computerized instructional communication substitute effectively for some face-to-face instructional communication?" Other disadvantages for students include comprehending a discontinuous, technical

innovation and learning how to use it effectively. This is tantamount to learning a new mode of communication. In addition, typing skills may constitute a significant threshold or barrier to adoption.

Disadvantages for faculty include comprehending a discontinuous innovation and then adopting that innovation. This disadvantage is more substantial for faculty than for students. Not only must faculty learn how to use the innovation, as must students, faculty must also learn how to produce CAI. As Allen, Hickey and Molise (1985) indicate, authoring systems are becoming more "user friendly" as higher-level packages are developed. Nonetheless, producing CAI is a quantum leap more innovative than using CAI.

Additional disadvantages for some faculty include learning instructional design principles independent of mode. That is, converting some courses to CAI is subverted not by the inherent character of course content or by authoring system limitations, but by failure of faculty to specify the competencies students are to achieve by term's end. If an instructor cannot specify the objectives of a course in terms of acquired student competencies, then converting such a course to CAI is hamstrung. Such limitations in course design speak to more fundamental problems in higher education than adoption of electronic text. A parallel issue is the absense of academic rewards for faculty to engage in such innovative instructional activities. Depending on the university involved, the rewards for innovation in teaching are relatively small compared to the rewards for professional development (publication).

Disadvantages for the university include hardware expenses, software expenses, and conversion expenses (including training many personnel in fundamentally new approaches to their work).

Electronic Discussion Groups

In many large universities, large lecture courses are supported by smaller discussion sections led by the instructor and/or teaching assistants. These discussion groups represent one arena in which electronic text services can support higher education. Two types of "computer teleconferencing" can be used to supplement large lecture courses with student-to-student and student-to-faculty communication. Synchronous teleconferencing involves simultaneous messaging via a keyboard to members of a conference or discussion group. Members of the discussion group would need to be "online" at the time. The software and hardware options available are many. Rice's (1984) work, The New Media: Communication, Research, and Technology, provides a review of these options. Asynchronous teleconferencing involves messaging between members of a discussion section where participation is on a "drop in" basis. Messages from student to faculty or student to student are stored in the system and distributed to group members when they "log on" to the system.

Relative advantage of electronic discussion groups to students include reduced transportation costs. Asynchronous discussion groups offer the added advantage of scheduling convenience. For faculty, the relative advantage includes (perhaps) fewer face-to-face contact hours and, with asynchronous teleconferencing, scheduling convenience.

Disadvantages for students include loss of face-to-face communication, the need to comprehend a discontinuous innovation, and the learning of a new mode of communication. As Rice and Williams (1984, p. 59) note, electronic text is regarded as "appropriate" for such acts as exchanging information but is less appropriate for "bargaining" and "negotiating." Clearly, electronic discussion groups fall somewhere between the extremes. The appropriateness of electronic text for discussion groups is an empirical question. Typing

ability is a significant threshold barrier. Disadvantages for faculty include comprehension of a discontinuous innnovation and adopting it for instruction purposes. As with CAI, the absense of objectives in terms of student competencies will make the design of electronic discussion sessions difficult.

Electronic "Office Hours"

One-on-one communication between professors and students during scheduled "office hours" is a hallowed tradition in higher education. In large universities, where student demand for such communication exceeds the supply perhaps by a power of ten, faculty "office hours" are often viewed as an adversary arena. "Good" teachers, in the traditional sense, welcome such face-to-face communication about student performance on past exams, study strategies for future exams, feedback on papers, and the like. Alternative demands on faculty time--scholarly research, committee assignments, community service--are also demanded by the university. Asynchronous electronic messaging is an alternative method of providing such student service functions. Again, Rice and Williams' (1984) use of appropriateness is relevant. Obviously, such electronic messaging cannot serve all student needs presently met by traditional faculty "office hours." Clearly, electronic messaging can only effectively substitute for some functions performed by office hours.

Relative advantage for students include scheduling convenience (some universities require fewer than two faculty office hours a week), reduced wait time (sometimes students wait for nearly an hour to meet with faculty, only to find that hours are "over"), reduced transportation costs, and (depending on system functions) a written record of the exchange. For faculty, relative advantage includes (perhaps) reduced face-to-face contact hours, scheduling

convenience, and a written record of the exchange.

Disadvantages for students include lost opportunities to build face-to-face rapport with faculty, to develop lasting collegial relationships that sometimes span the student's professional career. Can electronic messaging adequately substitute for the richness of face-to-face communication? Can lifelong friendships develop through electronic communication? Intuitively, such relationships seem unlikely. However, intuitive answers to empirical questions are a poor substitute for scientific evidence. Presumably, electronic messaging can substitute for only some of the communication that occurs during office hours. These disadvantages are in addition to those mentioned for CAI.

Disadvantages for faculty include the possibility of information overload. The finite time frame of office hours serves to "prioritize" (perhaps abusively) student-faculty exchange. The "priority" communication needs are those that wait outside faculty offices for attention. Switching to electronic messaging removes this "priority-setting" mechanism. As with students, the disadvantages for faculty include those previously mentioned.

Electronic Student Advising

One-on-one communication between counselor/faculty and students about the student's major, minor, general education requirements, and career trajectory is a fundamental function in higher education. This function is supported by a number of support materials or printed "handouts." The process is a dialogue dependent on the "richness" of face-to-face communication, on the nonverbal cues and nuances. To what degree can this face-to-face dialogue be adequately conducted through electronic messaging?

A two-step process is often involved in initial advising. First,

counselor/faculty must assemble information about the student advisee: test scores, transcripts, and the like. The student must provide some rather concrete statements about his or her objectives, preferences, and the like. The student also must be exposed to considerable background information. This first step in the process might be well served by electronic messaging.

The second step, the dialogue that brings all this information to closure in an action plan, is likely ill-served if face-to-face communication is entirely replaced by electronic messaging. That is an intuitive argument. Better answers come from scientific inquiry.

Students periodically require an advising update. Plans change; orientations change. Such changes reflect the growth of the higher education experience. Such updating might well be supplemented if not replaced by preliminary electronic messaging, followed by face-to-face advising.

Relative advantage for students include reduced transportation costs and scheduling convenience. In addition, by reducing the "rote" aspects of advising, by reducing faculty time involved in the "pro forma" aspects of preliminary advising, more faculty time in principle could be freed up for the more conceptual aspects of advising. This argument assumes that sophisticated software dedicated to the academic advising function is in place and that faculty know how to use that software. Depending on the electronic text system involved, a paper record of the advising exchange could be provided to the student.

Relative advantage for faculty include scheduling convenience and the availability of a permanent record of the advising exchange.

Disadvantages for both students and faculty are implicit in the statements above: loss of "richness" (perhaps) in communication between advisor and advisee. Can interpersonal friendships develop through electronic

messaging? At a more theoretical level, how will students and faculty evaluate the social presence (Short, Williams, and Christie, 1976) of electronic text? Other disadvantages mentioned with regard to other electronic text services also apply.

Electronic Catalog

Every university has a catalog that lists descriptions of all courses offered, provides background information on faculty, details requirements for majors and minors, and generally serves as the information repository, policy manual and "contract" between student and the university.

An electronic catalog could be made available for instant access and in updated form through a teletext or videotex system. The catalog could also be made available on diskette or casette tape. Because many of the economic restrictions of relatively "fixed-length" publications are removed through electronic publishing (at least in videotex, casette and diskette form), further detail can be provided through "supplements" requested by specific target audiences.

Relative advantage of the electronic catalog for students include (in "online" form) instant access to different annual issues of the catalog. If more detail is provided through "online supplements," the information function and utility of the catalog would be expanded. Faculty would enjoy similar advantages.

Disadvantages for both faculty and students involve the comprehension and adoption of the electronic text innovation, as well as other disadvantages previously mentioned.

Electronic Schedule of Courses

Every university publishes a "schedule of courses" to indicate the time and place that specific courses are offered for the current term. The schedule supplements the university's catalog with information of "short shelf life." As such, the schedule can take better advantage of the update flexibility of electronic text services.

Schedules of courses frequently require updates. New sections of large courses are offered. Additional discussion sections are added to large lecture courses at the last minute. Classrooms are changed in response to larger-than-expected or smaller-than-expected enrollments. Course times are sometimes changed. Such changes are inadequately communicated to students using printed schedules. Because this information is poorly communicated, students are often unable to take advantage of recently-added course opportunities, new sections, and the like.

Relative advantage of an electronic course schedule for students includes reduced transportation costs (no trips to campus to obtain updated information) and increased opportunity to take full advantage of course offerings based on the latest information. For faculty, relative advantage includes effective communication of program changes to prospective students and to advisees. When coupled with computer-aided registration (CAR), an electronic course schedule could more accurately match student demand to scarce university instructional resources.

Disadvantages for students include comprehension and adoption of the electronic text innovation. The same disadvantages apply to faculty as well.

Computer-Assisted Registration (CAR)

Most large universities have automated the process of enrolling students in courses. A "batch" processing philosophy tends to prevail, however, with only a fraction of the computer's organizing power called into play. In essence, registration is an attempt to match student demand for courses with available instructional resources and facilities. As a secondary function, registration can confirm course prerequisites.

The process is inherently iterative. That is, a student's initial choices for courses may not be satisfied. If sufficient numbers of students seek enrollment in a "demand" course, adding additional sections is one institutional response. Even if the institution chooses not to add new sections, an alternative student choice needs to be satisfied. With thousands of students requesting courses, making alternate selections, dropping out, or adding new courses over an extended period of time, both the "supply" and "demand" are fluid. Sophisticated computer software can manage such an environment. Airlines do so all the time. What's required is university orientation to "supply side" adjustment in schedules of courses offered. Such a system would likely require an electronic schedule of courses described above.

Relative advantage for students include fast, efficient, and responsive enrollment in courses desired. By checking prerequisites, CAR could reduce frustrations associated with "disenrollment" for prerequisite violations. If the university adjusts its "supply side" schedule of courses in response to demand, students are more likely to enroll in the courses they want or need. Relative advantage for faculty include more complete information on enrollments and opportunities for schedule adjustments, based on accurate information.

Disadvantages for students would include the comprehension and adoption of the electronic text innovation. Some students might rue the more efficient enforcement of prerequisites! Disadvantages for faculty may prove more substantial. An honored tradition in academia is the notion that faculty are given plenty of time to prepare for courses they will teach. Flexible "supply side" scheduling in response to student demand might well threaten this tradition. Careful planning could, of course, avoid such threats. However, administrators who might favor demand rescheduling might not be as sensitive to such concerns as faculty who must live with such rescheduling.

Electronic Course Syllabi

As the catalog is the repository of information and "policy manual" for the university, the course syllabus is the plan, policy manual and information repository for individual courses. At many large universities, the first week of instruction is largely a "shopping" week as students "browse" a large number of courses. "Browsing" involves some evaluation of the instructor but the course syllabus is an important source of information about course content.

In essence, information (provided by syllabi) that would have been most useful to students during registration is not available (or difficult to obtain) until instruction has already begun. By putting course syllabi "online" through an electronic text system, such documents could be made available to students when registration decisions are made. Syllabi could be coupled with past student evaluations of the instructor or the course. The course's grade point average could also be posted. Whether such additional information serves legitimate decision making or simply creates pressures toward grade inflation and "entertainment" teaching is both a philosophical

issue and an empirical question. Students requesting a syllabus could be asked to complete an evaluation form online, indicating their reaction to the course offering as described in the syllabus. Such diagnostics may prove useful in writing effective syllabi and in designing courses.

Electronic course syllabi could play an expanded function during the term as well. First, updates of the syllabus to reflect exam date changes, new assignments, and the like would be facilitated by an electronic course syllabus. A "tickler" message, notifying students of syllabus changes during logon procedures, would insure that students are notified of changes as those changes occur. This same "tickler" system could remind students of upcoming assignment deadlines as well. Second, course handouts of moderate length could be added as a supplement to the electronic syllabus. These could be added in response to changing circumstances in the classroom or be "programmed" for addition to course materials at a time selected for maximum impact by the instructor. Third, workbook exercises could be programmed for release at predetermined dates and added to the syllabus. At this point, the electronic syllabus melds into the domain of computer-aided instruction.

The relative advantage of the electronic syllabus for students include timely information about course content, grading policies, assignments, exams and the like when that information is needed most. As a "living" document, the syllabus is always "up to date," even when the student isn't. Faculty enjoy several relative advantages as well, including instant distribution of modifications of the syllabus, a useful "living" document for managing a course, and an easy mechanism (given "user friendly" design) for updating syllabi from term to term.

Disadvantages for students include unreasonable alteration in the original course "contract." The static quality of paper syllabi serve as a

restraint, perhaps, against ongoing changes in course content. Faculty, on the other hand, would be under formal or informal pressure to create or update syllabi prior to registration rather than prior to the first day of instruction! These disadvantages are in addition to those of comprehending and adopting the electronic text innovation.

The Electronic Bookstore

A university bookstore at the beginning of the term is generally comparable to Grand Central Station as rush hour. Never will so many attempt to purchase so much from so few! Students brave the chaos of the bookstore because they need information and because they must make purchases. Are the books for Poli Sci 25 in stock yet? What books are required? Recommended? How many books for Poli Sci 25 have already been sold? How many are left? The answers to these questions can be offered via one-way electronic text services, linked for immediate update to the bookstore's automated inventory system.

Two-way electronic text services, such as the INDAX shop-at-home services experimented with in San Diego in 1981, permit the next step in the electronic bookstore. By entering a credit card number or even using a university line of credit supported by scholarships and student loans, students could order books and supplies needed for courses. A delivery system would be required to make the system work, such as that offered by United Parcel Service. Such a delivery system could be linked to electronic library service to provide economies of scale.

Relative advantages of the electronic bookstore for students would include reduced transportation costs, avoidance of large, unruly crowds at the bookstore, 24-hour convenience (if such were offered) in ordering course books

and materials. Disadvantages include increased costs due to delivery charges, though those could be reduced by "ganging" orders with roommates and economies of scale that might result during periods of peak demand.

The Electronic Library

Many university libraries have already automated checkout procedures, records of holdings, the card catalog and other information bases. Many offer sophisticated searches of bibliographic data bases such as DIALOG and ERIC. However, these activities remain "brokered" activities conducted at considerable personnel cost by library staff. Just as banks have found automated teller machines an efficient way to reduce labor-intensive operating costs, so libraries might expand their services offered while reducing costs through the electronic library.

Presuming the development of "user friendly" software and systems to interface with existing automated library functions, many library tasks can be done from the home. The card catalog can be searched using keyword searching procedures. The required document can be located by automated search of the library's "current status" files (already automated for many libraries). The document can be "checked out" via a password to the (currently registered!) student, for pickup at a later time at the main library, at a satellite branch, or delivered to the home. An electronic messaging system could link the student to the information desk for non-routine information requests, including inter-library loans.

Relative advantage of the electronic library for both students and faculty include reduced transportation costs, convenience of 24-hour service (which the library could implement at a modest cost if it chose to), speed of searching for library holdings, and convenience of satellite or home delivery.

Disadvantages may include charges for use of computer searches and home delivery, as well as comprehending and adopting the innovation. Bibliographic searches may be among the most complex services to adopt.

The Electronic Campus Box Office

Most large universities host a number of athletic events, plays, concerts, art shows, lectures and the like. Keeping up with the myriad activities is non-trivial. Obtaining tickets for some activities is even more difficult. A campus electronic box office can help in both regards. A one-way electronic text system could serve the information needs by keeping students and other members of the campus community up to date on "what's happening." As with the electronic bookstore, a two-way electronic text system could support a booking service where tickets are ordered and paid for over the system.

Relative advantage of the electronic campus box office for students and other members of the campus community include easy access to information on "what's happening" as well as a convenient mechanism for ordering tickets or making reservations. Disadvantages include comprehending and adopting the electronic text innovation.

Electronic Student Record Service

Both students and faculty have occasional need for accurate, up-to-date student records, grade reports, and transcripts. Electronic student records, accessible through an electronic text system, would meet such needs. Adequate protection against unauthorized access would need to be designed into the system. When a "paper" document is required for "official" purposes, the electronic student record service could be used to "order" a paper document sent to the appropriate destination.

Relative advantage of an electronic student record service for both students and faculty include hassle-free access (assuming "user friendly" design) to needed records on an instant basis. Disadvantages include possible unauthorized access to student records and subsequent invasion of privacy.

Electronic Admissions Screening Service

The process of applying to a university involves a relatively standard set of information needs. High school or community college transcripts must be submitted, along with SAT scores and other indicators of the applicant's potential for successful studies at the university. These data must then be analyzed. While the task can completed manually, an electronic admission screening service could greatly speed the process and reduce the cost.

University applicants are unlikely to have had prior opportunities or motivation to comprehend or adopt the discontinuous innovation of electronic text. However, high school and community college counselors might well find such an electronic text service useful. By inputting information from the applicant (including name, address and phone), an initial screening of the student's eligibility for application can be made. Such services could be offered for a fraction of the cost of manual review for admissions. Applicants who appear close to eligibility can be mailed supplemental information from the university. Diagnosis of applicant information would permit instant provision of supplemental information to the applicant.

Relative advantage of an electronic admissions screening service for potential students include convenience, speed and reduced cost in determining eligibility for university admission. Disadvantages may include improper screening of applicants based on a strict algorithm that fails to take account of mitigating circumstances.

Electronic "Invisible Colleges"

In the services and products outlined above, applications of electronic text in support of higher education have emphasized student services. The potential is equally exciting with regard to faculty applications. Academic research and scholarship is inherently a collective activity. Faculty are linked together across large distances by common research interests and approaches, by shared paradigms. Electronic messaging services, organized around research interests or other scholarly pursuits, provide an important extension of telephone and mail services to facilitate the exchange of ideas. Because such services could be asynchronous, convenience of scheduling would be enhanced, especially with "invisible colleges" that span different time zones. A permanent record of the exchange would prove an invaluable tracer of the evolution of inquiry.

The concept of supporting invisible colleges on electronic text systems is elaborated by Hiltz and Turoff (1978, pp. 214-221). Indeed, the use of a computer conferencing system by scientists with the Energy Research and Development Administration (ERDA) and the Electric Power Research Institute (EPRI) generated the following self-reports (Hiltz and Turoff, p. 221):

> 1. Increased communication and perceived productivity through flexible working hours. Forty percent of the work sessions were prior to or subsequent to regular working hours. Ten percent occurred between 10 and 11 p.m.
>
> 2. Increased contact with distant colleagues.
>
> 3. Increased efficiency in use of other methods of communication, including electronic text communication before and after face-to-face meetings.
>
> 4. Increased precision in communication due to written transcripts of sessions.

5. Greater equality of participation among members of the "invisible college."

Studies to date indicate that such electronic text services might significantly improve the productivity of researchers. The true impact of such services are not likely to be realized until the participating population of researchers reaches a "critical mass," a number large enough and active enough to "draw" participation from its many members.

Relative advantage of an electronic "invisible college" include rapid dissemination of information among members of the "college," scheduling convenience, and permanent records of the scholarly exchange. Presuming integration of the electronic messaging system into the researcher's repertoire of thinking and communicating tools, the most profound advantage may well be a new way to "brainstorm" with colleagues that is analogous to and complementary with thinking and problem solving itself.

Disadvantages may include limited or expensive access to the electronic text service, higher priority tasks that may displace participation in the electronic college, and (last but not least) the ability to type. Further, simple typing skills are distinct from the ability to "compose on the keyboard," to use the electronic messaging system as an automated scratchpad. After Abraham Kaplan (1964, p. 3-11) such a dialogue among scholars pursuing a common line of inquiry should communicate the logic-in-use rather than the formal reconstructed logic of academic papers and articles considered in the next section.

Electronic Conventions & Journals

While the "invisible" college of close colleagues uses electronic messaging like an electronic scratchpad for collective brainstorming, electronic conventions and journals use teleconferencing and electronic

publishing in a more formal way. The electronic "scratchpad" in the section above serves as an informal communication tool and as an aid to the process of inquiry. The electronic convention is a forum for the formal reconstruction of that process, a computer teleconference where refereed papers are presented electronically, critiqued electronically, and subjected to scholarly questioning. Feasibility studies have been conducted by Aspen Systems Corporation and Westat Research Incorporated to explore just such a publishing system (Hiltz and Turoff, p. 236). As with student advising discussed in a prior section of this paper, much of the "rich" nonverbal communication embodied in a scholarly convention presentation and discussion are difficult to reproduced in electronic conventions. However, the limitations of computer teleconferencing must be learned from widespread experiences.

Electronic journals come very close to providing a natural fit of content with the capabilities of electronic text. Paper academic journals suffer from limited target audiences and high production costs per unit sold. Production costs have served to reduce the number of journals. While, on one level, such containment would seem to reduce information "overload," the practical effect is that journals trail the state of scientific inquiry by years. Staying current with the journals in one's area of scholarship means to stay current with the status of inquiry as it was 12, 18 or 24 months ago. This lag results in the creation and distribution of "fugitive" documents, which circulate within an invisible college and impact future inquiry. At the same time, fugitive documents are neither enlightening nor enlightened by the larger scholarly community. The impact is undesireable on any number of levels. Hiltz and Turoff (pp. 236-243) provide a detailed review of electronic conventions and journals.

Relative advantage of electronic conventions is reduced travel costs.

Advantages of both electronic conventions and journals include more rapid dissemination of scholarly findings, reduced distribution costs, and greater diversity of scholarly communication. Disadvantages include the possible emergence of "haves" and "have nots," determined by the individual scholar's innovative behavior with regard to electronic text or by the scholar's university's support of hardware/software costs of adoption. A "bandwagon" or "tipping point" effect can be predicted for the diffusion of electronic conventions and journals. In the inital stages, electronic papers and publications will lack the prestige and status of more conventional paper products. However, as the innovation diffuses through scientific and scholarly disciplines, the prestige balance can be expected to shift to electronic products, as electronic conventions and journals become central to communication in the scientific communities. As the innovation diffuses through the various social systems of the scientific and scholarly community, later adopters will find themselves isolated from the adoptive community to their increasing disadvantage. Because of the collective nature of inquiry, the impoverishment of any member of the community is an impoverishment of the entire community.

Toward a Research Strategy

The 15 electronic text services described above indicate the diversity of applications of electronic text in higher education. These applications of electronic text, along with system features or functions that each application requires, are summarized in Table 2. To understand the process of diffusion of these innovations, laboratory studies are recommended as a fruitful method of inquiry.

In the sections that follow, an experimental design is detailed. The

Table 2.

Various Electronic Text Services in Support of Higher Education and System Features Required to Support Such Services

(Refer to Table 1 for explanation of system features)

Electronic Text Service	Required System Features
Computer-Aided Instruction (CAI)	1, 2, 5, 9, 10, 11
Electronic Discussion Sections	1, 2, 3, 4, 5, 9, 10, 11, 13, 14, 15
Electronic Student Advising	1, 2, 4, 9, 10, 11, 13, 15*
Electronic Office Hours	1, 2, 3, 4, 9, 10, 11, 13, 15*
Electronic Schedule of Courses	1, 2, 5, 9, 15
Electronic University Catalog	1, 2, 5, 12, 15
Computer-Assisted Registration	1, 2, 3, 5, 9, 10, 11, 13, 15
Electronic Course Syllabus	1, 2, 5, 15
Electronic Bookstore (Inventory)	1, 2, 3, 5
Electronic Bookstore (Purchases)	1, 2, 3, 5, 9, 10, 11, 12, 13, 15
Electronic Library	1, 2, 5, 9, 10, 11, 12, 13*, 15*
Electronic Campus Box Office (Schedule)	1, 2, 3, 5
Electronic Box Office (Purchases)	1, 2, 3, 5, 9, 10, 11, 13*, 15*
Electronic Student Record Service	1, 2, 3, 5, 9, 10, 11, 13, 15*
Electronic Admissions Screening	1, 2, 3, 5, 9, 10, 11, 13, 15*
Electronic "Invisible Colleges"	1, 2, 3, 5, 9, 10, 11, 13, 14, 15
Electronic Conventions & Journals	1, 2, 3, 5, 9, 10, 11, 13, 14, 15

*Not required but strongly recommended for full relative advantage.

design is not proposed for a single experiment. Rather, the design permits the exploration of a number of research questions through a series of experiments that use the "template" described in the following sections as a starting point, but build variations on the design as appropriate. These experiments consider adoption at the individual level of analysis. Clearly, adoption decisions at the individual level of analysis are only relevant after an adoption decision has been made at the organizational level of analysis--by colleges and universities. However, rational decision making on the organizational level of analysis is, in turn, facilitated by an understanding of how individual students and faculty would react to electronic text services if they were available. While projected adoption is only a proxy measure in the lab for actual adoption in the field, projected adoption is a useful formative evaluation tool.

The lab studies would seek to link antecedent characteristics of potential adopters with projected adoption of the innovation. The experimental intervention, which would be modified in content as the series of experiments progresses, is exposure to demonstrations of the innovation, using either student services or faculty services described above (dependent upon the population of study) as simulation models. Projected adoption of electronic text services is a key dependent variable. Comprehension of the innovation and perceptions of its attributes are key intervening variables.

Embedded in the model are two distinct formative evaluation questions. The first question involves the basic marketing question of bundling of services. As indicated by some qualitative research, something akin to "critical mass" occurs when a number of electronic text services are bundled together in a combined service package. That is, while none of the individual services is viewed as possessing significant relative advantage, the

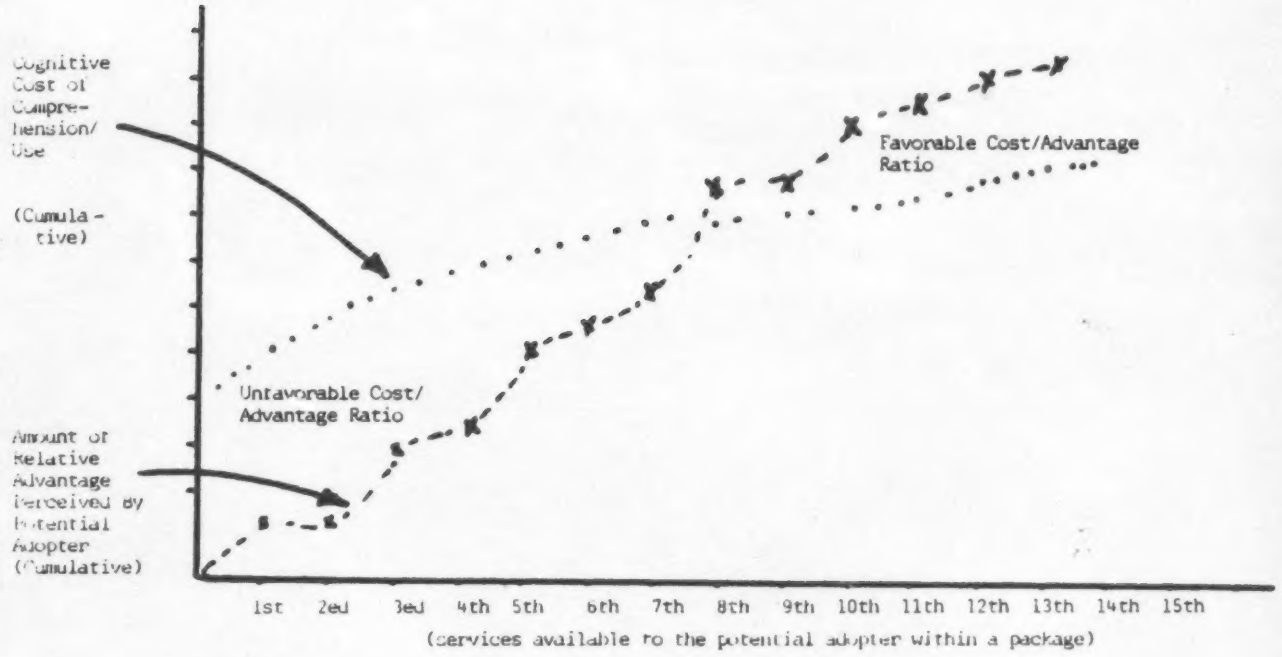
combination of all the services together triggers a decision to adopt, as projected through measures of willingness to pay. This type of adoptive behavior is consistent with the notion of adoption thresholds and resistance levels to adoption.

In theoretical terms, an individual evaluating a discontinuous, technological innovation such as electronic text must master a number of cognitive tasks. These tasks are prerequisites to comprehending and using the innovation. This cognitive task stands as a barrier to adoption, a threshold of resistance that must be overcome before adoption can occur. What motivates the individual to overcome this barrier? The perceived attributes of the innovation, particularly its relative advantage, provides the energy needed to overcome thresholds or barriers to adoption. With regard to electronic text in higher education, each service described in the prior section of this monograph provides an alternative to other, more-familiar approaches for obtaining the same service. While specific relative advantages were mentioned for each of the services described in the previous section, these service-specific advantages may prove in isolation to be insufficient to overcome thresholds or barriers to adoption. They may provide insufficient reward to make the comprehension and mastery of the innovation worthwhile.

However, the marginal cognitive cost of adopting a second, third, or fourth electronic text service is small in comparison to the initial cognitive cost of adopting the user's first electronic text service. Thus, the small perceived relative advantage of each additional service accumulates while the additional cognitive cost begins to "level off" as each additional service is adopted.

This relationship is illustrated in Figure 1. While the cumulative cognitive "cost of comprehension/use" generally "flattens" as additional

Figure 1. The Relationship Between the Cumulative Cost of Comprehension/Use and the Cumulative Relative Advantage of Electronic Text Services


Cognitive Cost of Compre-hension/ Use
(Cumula-tive)
Favorable Cost/Advantage Ratio
Unfavorable Cost/ Advantage Ratio
Amount of Relative Advantage Perceived by Potential Adopter (Cumulative)
1st 2ed 3ed 4th 5th 6th 7th 8th 9th 10th 11th 12th 13th 14th 15th
(services available to the potential adopter within a package)

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services are added to the user's interconcept network and scripts, the process is not a even one. Different services require different cognitive skills; the "cost of comprehension/use" curve is "bumpy." Likewise, the cumulative perceived "relative advantage" curve is also "bumpy." Some services, as they are comprehended and used, provide no cumulative increase in perceived advantage. Other services, once comprehended, substantially increase the relative advantage of the electronic text package or bundled service as a whole. Further, the slope, intercept, and shape of the two curves likely vary across individuals and across varying service components. Multiple measures of the dependent variable (projected adoption) during the simulation experience permits exploration of the "critical mass" research question explicated in Figure 1.

The second research question involves the process of evaluating a discontinuous, technological innovation itself. What are the relations between relative advantage, complexity, interconcept networks, scripts, comprehension, and projected adoption? When an individual encounters a university-based electronic text system for the first time, the first cognitive task is one of comprehension. Borrowing heavily from Hirschman's theory of consumer creativity, the individual is posited to construct an interconcept network by discerning attributes of the innovation that are similar to and different from other, known products and services within the same product class. The individual is also posited to construct scripts for using the innovation, based on prior experiences using other products in the same product class. This process of building the innovation into the potential adopter's interconcept network and identifying appropriate scripts for its use affects—and is affected by—perceptions of the innovation's complexity. At the same time, increased comprehension of the innovation

affects perceptions of its relative advantage. Empirical generalizations from classical diffusion research suggest that shifts in perceived attributes of the innovation (complexity and relative advantage) should impact projected adoption. Each of these constructs can be measured prior to, during, and following the electronic text simulation experience.

With these research questions as a backdrop, the constructs can be laid out in a causal model. This model is displayed in Figure 2. Each of the key constructs is described in the subsections that follow.

Perceived Attributes

Closely linked to comprehension of the innovation are perceptions of its attributes. To operationalize this construct, the subject may be asked to rate each service according to its complexity, relative advantage, trialability, observability and compatibility. What is the relationship between comprehension and perceived attributes? The effort here is to link the constructs specific to discontinuous, technological innovations with the overarching concepts of perceived attributes general to all innovations. The open-ended comments and responses of electronic text users serve as a fertile source of operational statements about the innovation of electronic text.

Prior research indicates that perceived attributes are powerful predictors of adoption. That is, the concepts of relative advantage and compatibility in particular and the other three attributes in general may prove more powerful in predicting adoption than the antecedent characteristics of the individual (Ostlund, 1974, p. 28). The relative contributions of perceived attributes and antecedent characteristics can be assessed through the research design implicit in Figure 2.

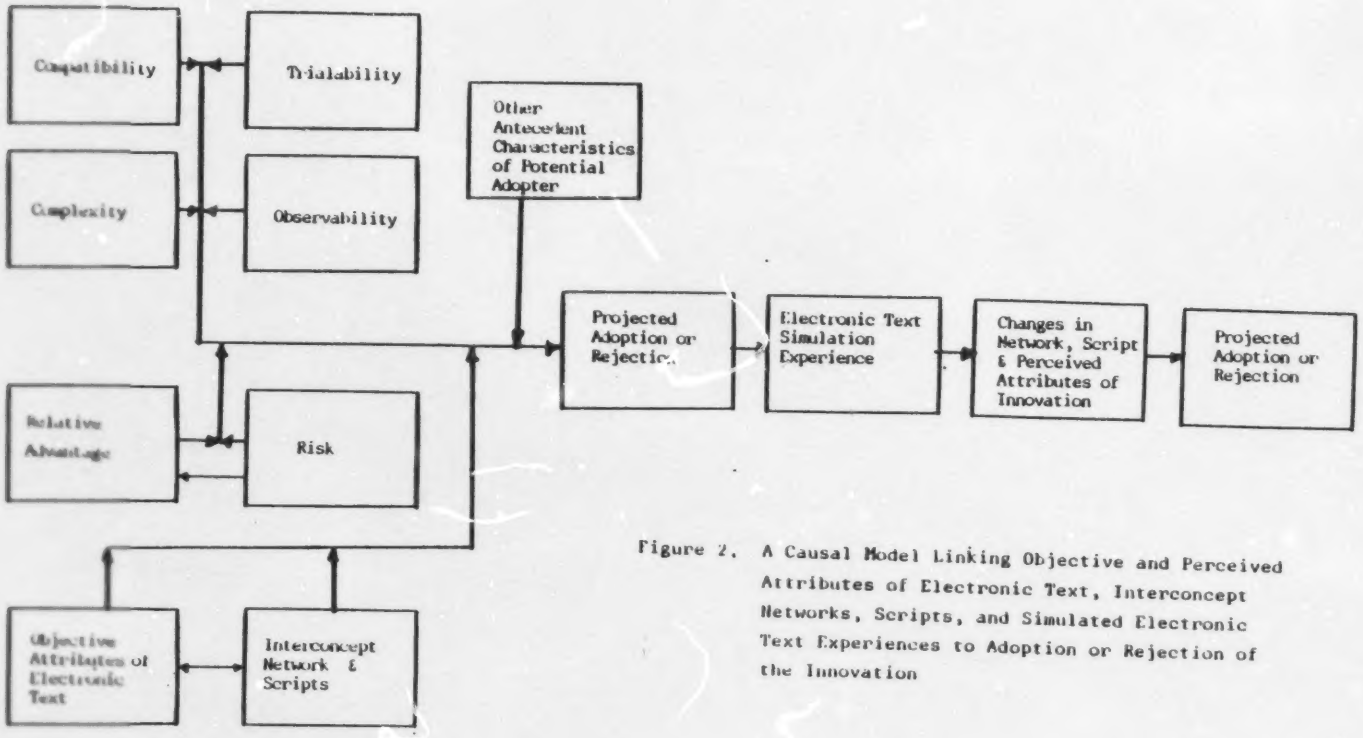

Figure 2. A Causal Model Linking Objective and Perceived Attributes of Electronic Text, Interconcept Networks, Scripts, and Simulated Electronic Text Experiences to Adoption or Rejection of the Innovation

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Other Antecedent Characteristics

Subjects exposed to simulations of different electronic text services will bring a set of relevant antecedent characteristics to that situation. These antecedent characteristics will impact interconcept networks and scripts and, in turn, comprehension of the innovation and perception of its attributes. The antecedent characteristics may also directly impact projected adoption of electronic text, independent of the simulation experience.

What are the relevant antecedent characteristics? Some include the subject's age, the subject's concern about loss of social contact, and prior experiences in the product class. Hirschman (1980, p. 288) suggests that novelty seeking, non-overlapping role accumulation, and use innovativeness are characteristics that subjects bring into the situation that affect adoption. Creativity is postulated to be an important antecedent characteristic

Specific to electronic text in higher education, antecedent characterstics postulated to have impact on adoption include transportation and scheduling concerns. As indicated in most of the previous subsections about potential electronic text services in higher education, reduced transportation need/costs and greater scheduling convenience were earmarked as key relative advantages of electronic text. Most services presume that the user's terminal would be located in the user's home and that many of the services could, in principle, be available 24 hours a day. These postulated advantages, of course, would exert maximum impact on those individuals for whom transportation and scheduling under the status quo prove a significant disadvantage. Electronic text is most advantageous to individuals taking correspondence courses, individuals living large distances from campus, and individuals whose roles in the home or out of home make scheduling and transportation problematic. In a laboratory setting, participating subjects

ought to be drawn in part from the population of students meeting these characteristics. In this manner, these key antecedent characteristics can be measured and analyzed for impact on subsequent variables in Figure 2.

Still other important antecedent characteristics are unknown. The goal in collecting background data of relevance would be to overcollect rather than undercollect.

Objective Attributes of Electronic Text

Given the rapid proliferation of personal computers and mass media attention to videotex and teletext services, many subjects participating in electronic text simulation experiments will have prior knowledge of electronic text. As such, they have some notion of the objective attributes of electronic text. This is especially true of individuals with prior "hands on" experiences with computers. The objective attributes, then, play some role in the formation of perceived attributes of the innovation, mediated by other antecedent characteristics of the individual. Further, both the functions and services of electronic text are systematically manipulated during the simulation experience itself. Due to this manipulation, exposure to the objective attributes affect interconcept networks, scripts, comprehension, and perceived attributes of the innovation.

Interconcept Network & Scripts

According to Hirshman (1980), the process of comprehending a discontinuous, technological innovation and evaluating its perceived attributes involves interconcept networks and scripts. Interconcept networks can be operationalized by having subjects evaluate pairs of product/services, one being the particular electronic text service being simulated and the other being another product/service within the product class. Subjects may be asked

to list as "many similar or dissimilar attributes as s/he can for each pair" (Hirschman, 1980, p. 290). Scripts can be operationalized by having subjects describe situations in which the electronic text service could be used, other than those illustrated in the simulation. This kind of ambiguous, open-ended measure of scripts is vulnerable to severe measurement error. However, the initial open-ended measures used in early experiments can serve to stimulate more precise, reliable, closed-end measures while maintaining face validity.

Comprehension of the innovation is indicated by the density of correct interconcept linkage (some links may be factually incorrect) and the variety of situational repertoire indicated by the subject. These relatively open-ended measures could be supplemented by brief, close-ended probes about specific scripts ("Could this service be used to ...?) and product linkages ("How is this service different from the last service we looked at?"). Relationships between functions or features (see Table 1) and services or applications (see Table 2) provide an alternate operationalization of comprehension.

Electronic Text Simulation Experience

While the design is appropriate for both faculty and student populations, simulation of student electronic text services provides an illustrative example. Subjects selected from the population of regular and extension studies students may be exposed to laboratory simulations of the 13 student-oriented services described above. Using a microprocessor and special simulation software, each subject is demonstrated computer-aided instruction, electronic discussion groups, electronic office hours, and so forth. The order of presentation may be rotated for different subjects to control for interaction effects. The contributory constructs of interconcept networks and

scripts and the intervening constructs of comprehension and perceived attributes are measured specific to each permutation of the innovation. Partial measures of the dependent variable, projected adoption of electronic text, may also be made during the simulation experience.

Changes in Interconcept Network, Scripts, and Perceived Attributes

As indicated in Figure 2, the electronic text simulation experience is hypothesized to exert some measurable impact on the subject's interconcept network, scrips, and perceived attributes of electronic text. The relationship is postulated to be reciprocal. That is, as the interconcept network becomes more detailed and interlocked, as scripts are fleshed out and ambiguities of process are resolved, so too does perceived complexity decline, relative advantage increase, and so forth. As trailability and observability are manipulated through the simulation experience, changes in those perceived attributes also serve to interconnect the network and provide more scripts or episodic schema for the subject. All of these changes influence the adoption/rejection decision.

Projected Adoption or Rejection

Adoption of electronic text services at the individual level of analysis is the dependent variable of inquiry. What factors lead to the adoption or rejection of electronic text services in the context of higher education?

As indicated above, actual adoption of electronic text services requires the prior adoption of such systems by educational institutions. Major software development and hardware acquisition must precede adoption decisions by individual students and faculty. Extensive human resource development is required subsequent to software development and hardware

acquisition, as universities show faculty and staff how to transform the way they do their jobs.

Therefore, researchers must content themselves, for the time being, with measures of projected adoption. Projected adoption is of the form: "Would you use this innovation if it were made available to you?" Or: "How much would you be willing to pay for this innovation?" Projected adoption is a proxy measure for a phenomenon not easily measured: actual adoption.

Because the construct of projected adoption is a proxy measure, multiple measures must be taken in order to "triangulate" on the underlying construct. First, each individual electronic text service must be evaluated in terms of projected adoption, based on the subject's willingness to pay. Because of the setting, such measures might be linked to student tuition or fees. Subjects might be asked:

> "Suppose you had to pay an additional charge each term to use this electronic text services. This fee would be collected along with your other tuition and student fee payments. How much would you be willing to pay each term for this electronic text service?"

This provides a concrete, metric measure of projected adoption based on willingness to pay.

This single measure, however, is misleading. First, individual users may not be given the option of adopting or rejecting the innovation. Some universities may simply mandate adoption for all students by implementing such a system and passing hardware, software and human resouces development costs on to the student through mandatory fees. Under such circumstances, willingness to use the innovation, rather than willingness to pay for the innovation, has more validity (on the face of it) as a proxy measure of adoption.

Operationally, subjects could be asked to rate their projected

frequency of use of a given electronic text service, using a one to ten scale, where one indicates the subject will "never" use the innovation and ten indicates the subject will "always" use the innovation. Subjects could also provide projections of the importance of availability of each service. In addition, a modified form of the semantic differential could be used to measure projected adoption. As with all electronic text services, the innovation replaces or augments functions already performed by potential adopters through some other means. (Only in rare circumstances does electronic text provide a wholly new and unique service.)

This fact can be used to measure projected adoption. The subject could be asked to evaluate two methods to "find out if the books I need next term are available in the bookstore." The subject would indicate a preference for the traditional approach or the electronic text approach by marking the proper position between the colons:

GO TO THE BOOKSTORE	: : : : : : : : :	CHECK IT OUT THROUGH ELECTRONIC BOOKSTORE

Such an evaluation would follow a simulation of the "electronic bookstore" service discussed in a previous section. A series of paired comparisons could be made in this manner, examining different "scripts" for using the "electronic bookstore" innovation and other electronic text services.

Regarding bundling of electronic text services, subjects can be queried as to how they would bundle electronic text services. This process could be facilitated by asking subjects to select only three services from among the 13 available to be included in a "basic" bundle of services for students. Subjects could then be asked in open-ended probing to explain the rationale for their choices. Subject could also indicate the perceived value or relative advantage to each component. Such data would help assess the

relationship between cognitive cost and perceived relative advantage as posited in Figure 1.

Electronic text services for students served as focus of inquiry in the experimental "template" described above. A similar strategy could be applied to the study of electronic text services for other sectors of the higher education community. As hinted at in this paper, electronic text services for faculty could offer significant relative advantages over conventional methods of scholarship. Various staff functions could also be facilitated by electronic text services. The acceptance or rejection of these services could be studied through the use of simulation of such services under laboratory conditions similar to those described for students.

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